May 24, 1965

## LINEAR PHASOLVER MEASURING ENGINE

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Some learning time has been required in using the test procedures and test equipment for the measurement of the performance of the linear phasolver. The actual measuring is being done by [redacted] closely supervising. The test dimensions are gage blocks. To get different dimensions, [redacted] wrings two or more gage blocks together. The wringing process is surprisingly repeatable, to 1/10 micron.

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[redacted] quickly mastered the repeatability of the physical set-up, i.e. tilt or skew of the gage blocks and precise contact pressure on the ends of the gage glock. Thermal changes associated with handling the gage blocks turned out to be the most troublesome. They have worked out a routine of minimum handling and, in addition, between measurements they place the steel gage blocks on a large steel plate to improve thermal stability. The techniques have been successful in decreasing thermal variations considerably. Room temperature remains constant to about $1^{o}$ and humidity constant within about 2% or 3%. They cannot control temperature and humidity to a specified value other than what the system naturally gives them. They maintain a 24 hour record of temperature and humidity.

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With the improved thermal stability, [redacted] has taken 5 gage blocks and is able to obtain day to day repeatability of the 5 measurements to better than $\pm\frac{1}{2}$ micron. These five blocks are:

1.) 8 mm plus 15 mm = 23 mm

2.) 30 mm single block

3.) 60 mm single block

4.) 125 mm single block

5.) 250 mm single block

[redacted] has reduced the non linearity of measurement within a pole pair by electrical balancing of pattern capacity and quadrature. They started out with 60 microns peak non linearity with a half harmonic type of variation. He brought this to zero by adjusting pattern capacitance. A first harmonic non linearity then showed up with a peak to peak amplitude of about 5 microns. By adjusting the quadrature relationship of the driver signals, the amplitude was brought down to about 0.8 microns peak to peak. It may be possible to further reduce the non linearity within a pole pair (i.e. within 1 mm) by more refinement of adjustments. [redacted] would like to discuss this with [redacted] their consultant first, however.

There is systematic scale error which amounts to about 18 microns in the 20 inch length of the pattern. They have not yet determined whether or not the scale error is in the patterns or whether they can readily correct it. It may not be appropriate to attempt such a correction in the present feasibility phase. Since it is systematic, the error could be compensated by computer program correction of the measurement. [redacted] has demonstrated some remarkable precision in the measuring device. He is able to split 1/10 micron into 4 parts with the aid of a [redacted] microinch meter (there are 4 microinches in 1/10 micron). His 1/10 micron count changes at the same quarter point each time. Since the phasolver patterns are analogue devices, [redacted] believes he could resolve 1/100 micron if he had another digit on the counter. This demonstrates excellent stability in the electronics and remarkably fine detection of the zero crossover point of the electrical signal.

[redacted] mentioned that if the spacing between plates could be reduced to perhaps 100 microinches, it would improve sensitivity and make him more confident of resolving 1/100 micron. I don't recommend it, as such a small spacing increases the cleanliness problem.

A group from [redacted] will visit [redacted] on Thursday, May 27, to discuss application of the linear phasolver to the stereo measuring instrument.

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